

ApprenticeshipsNI



# City & Guilds Certificate of Electrotechnical Technology

## 2330 Level 2

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## Detailed Scheme of Work for the Directed Learning Programme

### 2010 Intake

### Enniskillen Campus

## *Management of Learning*

- *This Document*

This document has been prepared in order to better inform the Employer and Apprentice in their understanding of the Directed Learning programme that ETT has arranged with the local College. The programme of learning as it appears on the next page should be considered as indicative only. In most cases this programme will be adhered to but please note that the nature of teaching and learning on this course may from time to time bring about some variation to the planned delivery of the syllabus.

- *Scheme of Work*

The pages that are numbered consecutively from Page 1 through to Page 29 are derived from the actual City & Guilds 2330 Syllabus. We have been able to set this to a "*Scheme of Work*" with the aim of providing greater visibility and programme awareness for the Employer.

- *Personal Training Plan*

The Scheme of Work will be incorporated into an overall *Personal Training Plan* (PTP) for the Apprentice and this will serve as a common reference or base document from which the involvement and understanding of the Employer and Apprentice in the Directed Learning and Workplace experience can be strengthened.

- *The Objective*

The objective of this document is to place in the hands of Employers for the first time, useful and detailed information on the Directed Learning course content with timescales and achievement targets for individual Apprentices. This will help facilitate the Employer and Apprentice with an improved and clearer understanding of the planned Directed Learning programme.

- *Employer Engagement*

ETT Industry Training Officers will provide structured and scheduled reports to Employers throughout the year covering the progress and achievement of the Directed and Workplace Learning for each Apprentice. *Employer engagement* and awareness in the Learning process is a vital and essential factor contributing towards the progress and successful outcome of the Apprentice.

- *Revision*

Revision is an essential aspect of this course. Most young people who undertake planned and regular revision at home significantly improve their opportunity for progression towards a successful outcome.

## Detailed Scheme of Work for 2330 Level 2

### SWC – Enniskillen Campus

		Induction (ETT/College induction, CSR, 1 <sup>st</sup> Aid and WAH)	N/A	Week No.
<b>Unit 1</b>	<b>Working effectively and safely in the electrotechnical environment</b>		<b>Pg. Ref.</b>	<b>Week No.</b>
	<b>Outcome</b>			
(201)	1	Identify the legal responsibilities of employers and employees and the importance of health and safety in the working environment	2 – 4	3 – 4
	2	Identify the occupational specialisms	5 – 6	5
	3	Identify the sources of technical information	7	6 (201)
<b>Unit 2</b>	<b>Principles of electrotechnology</b>		<b>Pg. Ref.</b>	<b>Week No.</b>
	<b>Outcome</b>			
(202)	1	Describe the application of basic units	9 – 10	7 – 8
	2	Describe the basic scientific concepts	11 – 12	9 – 12
	3	Describe basic electrical circuitry	13	13 – 14
	4	Identify tools, plant, equipment and materials	14	15 – 17
<b>Unit 3</b>	<b>Application of Health and Safety and the Electrical principles</b>		<b>Pg. Ref.</b>	<b>Week No.</b>
	<b>Outcome</b>			
(203)	1	Safe systems of work	16 – 17	18 – 20
(204)	2	Use of technical information	18	20 – 21
	3	Electrical machines and a.c. theory	19	22 – 24
	4	Polyphase systems	20	25 – 26
	5	Overcurrent, short circuit and earth fault protection	21	26 – 28 (202 & 203)
<b>Unit 4</b>	<b>Installations (Buildings and Structures)</b>		<b>Pg. Ref.</b>	<b>Week No.</b>
	<b>Outcome</b>			
(205)	1	Regulations and related information for electrical installations	23 – 24	29 – 30
(206)	2	Purpose and application of specifications and data	25	30 – 31
	3	Types of electrical installations	26 – 27	32 – 33
	4	Undertake electrical installation	36 – 40 (204 & 206)	34 – 35 (205)



Multiple Choice On-line Assessment (GOLA)



Assignment/s

# Unit 1 – 201 Working effectively and safely in an electrotechnical environment

## Rationale

The aim of this core unit is to develop the candidates' ability to identify and work within the parameters set by current health and safety legislation and best practice related to the Electrotechnical Industry.

This unit is concerned with the requirements that are essential to enable electrotechnical activities to be carried out safely and effectively. It includes dealing with statutory and organisational requirements in accordance with approved regulations, codes of practice and procedures. It covers responsibilities, accident reporting and the identification of hazards and risks.

There are three learning outcomes to this unit. The candidate will be able to

1. identify the legal responsibilities of both employers & employees and the importance of health and safety in the working environment
2. identify the occupational specialisms within the breadth of companies that form the electrotechnical industry Identify sources of technical information and methods of retrieval and use drawings, diagrams and manufacturers' data .

## Connection with other awards

This core unit combines with units 2 and 3 and one of the occupational units (4-9) to form the Level 2 Certificate in Electrotechnical Technology

## Assessment

1. Practical Activities  
There is no formal practical assessment for this unit but candidates will be expected to demonstrate the skills learnt through a range of practical activities.
2. Written Tests  
The underpinning knowledge requirements are listed for each outcome. These will be assessed by a multiple choice question paper produced in accordance with the test specification.

# Outcome 1: Identify the legal responsibilities of both employers and employees and the importance of health and safety in the working environment

## Practical Activities

The candidate will be able to

- 1 Identify, select and use Personal Protective Equipment (PPE) appropriate for the task being undertaken
- 2 follow agreed procedures for obtaining and returning specialist PPE after use
- 3 recognise warning, advisory, mandatory and prohibition signs
- 4 follow accident and emergency procedures

## Underpinning Knowledge

The candidate will be able to:

- 1 state the legal responsibilities within the Health and Safety at Work Act (1974) for the
  - a employer
  - b employee
- 2 list the current Health and Safety legislation relevant to the workplace/site within the electrotechnical Industry
- 3 identify from the following, those regulatory requirements which are statutory and those which are non-statutory
  - a Health & Safety at Work Act (1974)
  - b Electricity at Work Regulations (1989)
  - c The Electricity Safety, Quality and Continuity Regulations 2002 (Formerly Electricity Supply Regulations 1989)
  - d Management of Health & Safety Regulations (1992)
  - e Provision & use of Work Equipment Regulations (1992)
  - f COSHH Regulations (2002)
  - g Personal Protective Equipment Regulations (1992)
  - h BS 7671 Requirements for Electrical Installations
- 4 state the main responsibilities of employers towards the maintenance of health and safety
  - a making the workplace safe and without risk to health
  - b keeping dust, fumes and noise under control
  - c ensuring plant and machinery are safe and that safe systems of work are set and followed
  - d ensuring articles and substances are moved, stored and used safely
  - e providing adequate welfare facilities
  - f providing adequate information, instruction, training and supervision necessary for staff's health & safety
  - g providing a health & safety policy statement if there are five or more employees
  - h providing any protective clothing or equipment specifically required by the Health & Safety Act
  - i reporting certain injuries, diseases and dangerous occurrences to the enforcing authority
  - j providing adequate first aid facilities
  - k undertaking precautions against fire, providing adequate means of escape and the means of fighting fire
  - l displaying a current certificate as required by the Employers Liability (Compulsory Insurance) Act 1969

- 5 state the responsibilities of an employee as being
- a taking reasonable care for your own health and that of others who may be affected by what you do or may not do
  - b co-operating with your employer on health and safety issues
  - c not interfering with or misusing anything provided for health and safety or welfare in the workplace
  - d reporting any identified health and safety problem in the workplace, in the first instance to the supervisor, manager or employer
- 6 explain the use of personal protective clothing appropriate to the task being undertaken
- a eyes
    - i spectacles
    - ii goggles
    - iii face screens
    - iv helmets
  - b head and neck
    - i. helmets
    - ii. bump caps
    - iii. hairnets
    - iv. sou'westers
    - v. cape hoods
  - c ears
    - i. earplugs
    - ii. muffs
  - d hands and arms
    - i gloves
    - ii gauntlets
    - iii mitts
    - iv wrist cuffs
    - v armlets.
  - e feet and legs
    - i. safety (boots, shoes, trainers)
    - ii. gaiters
    - iii. leggings
    - iv. spats and clogs
  - f lungs
    - i. disposable respirators
    - ii. half-masks
    - iii. full face respirator with filtering cartridge
    - iv. powered respirator blowing filtered air to a mask
    - v. fresh air hose equipment
    - vi. breathing apparatus (self-contained and fresh air line types)
  - g whole body
    - i. conventional or disposable overalls
    - ii. boiler suits
    - iii. warehouse coats
    - iv. donkey jackets
    - v. high visibility clothing
    - vi. chemical suits
    - vii. thermal clothing
    - viii. safety harness.
- 7 state the need for isolation before any work is carried out on an electrical installation or system

8. identify types and meaning of safety signs
  - a warning
  - b advisory
  - c mandatory
  - d prohibition
  
- 9 follow accident and emergency procedures
  - a recognise situations which could lead to accidents
  - b detail the procedures to be followed in the event of an accident
  - c Identify the location of first aid facilities
  - d state accident reporting procedures
  - e recognise emergency procedures
  
- 10 state the basic action to be taken in the event of electric shock
  - a do not touch the casualty
  - b isolation of supply
  - c removal from live source using insulating material
  - c first aid through resuscitation
  - d treatment for burns, shock
  
- 11 identify types and applications for fire extinguishers
  - a water
  - b powder
  - c foam
  - d gas

## Outcome 2 Identify the occupational specialisms within the breadth of companies that form the electrotechnical Industry

### Practical Activities

The candidate will be able to

- 1 Produce an organisational flow chart to show the structure of company staff from owner/managers to operatives
- 2 identify role and responsibilities within the place of work

### Underpinning Knowledge

The candidate will be able to:

- 1 describe briefly the service provided within the following specialisms
  - a lighting installations
  - b power installations
  - c emergency lighting
  - d security systems/alarms
  - e building management systems
  - f control systems
  - g instrumentation
  - h electrical maintenance
  - i computer installations
  - j fibre optics
  - k data infrastructure cabling
  - l HV/LV Jointing
  - m public lighting
  - n panel building
  - o electrical machine drive installations
  - p consumer/commercial electronics
- 2 state that organisations that have electrotechnical activities can be
  - a Electrical Contractors
  - b Factories
  - c Process Plants
  - d Local Councils
  - e Commercial/Business buildings and complexes
  - f Leisure Centres
  - g Panel Builders
  - h Motor rewind & repair companies
  - i Railways
  - j Armed Forces
  - k Hospitals
  - l Equipment and machine manufacturers

- 3 state the role of the following personnel within an organisation that has electrotechnical activities.
- a design engineer
  - b maintenance manager/engineer
  - c service manager
  - d estimator/cost engineering
  - e contracts manager
  - f project manager
  - g technician
  - h supervisor/foreman
  - i operative-installation; maintenance; servicing
  - J mechanic/fitter – installation; maintenance; servicing
- 4 identify those Professional bodies, Trade and Employer Associations, Trade Union and Regulatory bodies associated with a specific specialist company in the electrotechnical industry.

## Outcome 3 Identify sources of technical information and methods of retrieval and use drawings, diagrams and manufacturers' data

### Practical Activities

The candidate will be able to

1. retrieve technical information
2. use diagrams, charts and data
3. use BS and/or BSEN symbols to identify required equipment, machines, switchgear, accessories in the workplace or on site

### Underpinning Knowledge

The candidate will be able to:

- 1 state that sources of technical information include
  - a British Standards Institute (BSI)
  - b BSEN Harmonized Standards
  - c Codes of Practice
  - d libraries (eg IET )
  - e manufacturers' catalogues, manuals
- 2 explain that technical information maybe retrieved by using
  - a conventional drawings, diagrams
  - b CD-ROM
  - c DVD
  - d video tapes
  - e VDUs/internet
  - f facsimile (fax) machines
  - g E-mail
  - h USB flash memory keys
- 3 identify types of drawings and diagrams as:
  - a circuit diagrams
  - b wiring diagrams
  - c block diagrams
  - d location drawings
  - e assembly and detail drawings
  - f distribution cable route plans/drawings
  - g site plans
  - h data sheets and wall charts
  - i component positional reference systems
  - j manufacturers' data and service manuals
- 4 identify and describe, how and why different scales are used to produce drawings, plans and diagrams relevant to the workplace
- 5 recognise and explain how B.S.E.N 60617 symbols are used
- 6 state the necessity to use drawings, diagrams in conjunction with the related specification

## Unit 2 - 202 Principles of electrotechnology

### Rationale

The aim of this core unit is to enable the candidate to understand the purpose and fundamental principles of electro technology within the industry specialisms

There are four learning outcomes to this core unit. The candidate will be able to

1. Describe the application of the basic units used in electro technology.
2. Describe basic scientific concepts related to electro technology.
3. Describe basic electrical circuitry and applications
4. Identify tools, plant, equipment and materials used for electrotechnical applications

### Connection with other awards

This core unit combines with units 1 and 3 and one of the occupational units (4-9) to form the Level 2 Certificate in Electrotechnical Technology

### Assessment

1. Practical Activities  
There is no formal practical assessment for this unit as candidates will be expected to demonstrate these core skills through practical activities in other units.
2. Written Tests  
The underpinning knowledge requirements are listed for each outcome. These will be assessed by a multiple choice question paper produced in accordance with the test specification.

# Outcome 1 Describe the application of the basic units used in electro technology

## Practical Activities

The candidate will be able to

- 1 measure low voltage current using an ammeter or multimeter
- 2 measure resistance in a battery operated circuit
- 3 use a range of instruments to measure basic units

## Underpinning Knowledge

The candidate will be able to

- 1 state the relationship between
  - a force and its effect on movement
  - b force, mass and acceleration (the Newton)
  - c mass and weight, the effect of gravitational pull
  - d force times distance moved in the direction of the force
- 2 identify the SI Unit, multiple, sub-multiple, symbol and quantity for
  - a current
  - b potential/pressure
  - c resistance
  - d resistivity
  - e temperature
  - f mass
  - g force
  - h magnetic flux
  - i magnetic flux density
  - j period
  - k frequency
  - l power
  - m energy
  - n time
  - o length
  - p area
  - q weight
- 3 describe how the SI Units in 2 (a-q) relate to the fundamental principles of
  - a electrical, electronic, and magnetic circuits
  - b alternating current production
  - c electrical machine efficiency
  - d mechanical lifting devices
- 4 state the relationship of
  - a resistance
  - b resistivity
  - c length
  - d area when applied to conductors, cables
- 5 state the construction features and operating principles of a simple alternator

- 6 state with the aid of diagrams how the alternator produces an output that follows a sinusoidal waveform pattern
- 7 state the efficiency of a machine in terms of output (energy or power) / input (energy or power) as a percentage.

## Outcome 2 Describe basic scientific concepts as related to electro technology

### Practical Activities

The candidate will be able to

- 1 connect conductors and simple electrical loads to an ELV source to form
  - a open and closed circuits
  - b series and parallel circuits
- 2 connect switches, lamps and measuring instruments into an ELV circuit
- 3 construct a diagram for a sinusoidal waveform and indicate
  - a average, RMS, peak or maximum values
  - b peak to peak
  - c period and frequency

### Underpinning Knowledge

The candidate will be able to:

- 1 list the materials used as conductors across the specialisms within the electrotechnical industry
- 2 list the materials used as insulators across the specialisms within the electrotechnical industry
- 3 state in simple terms, the reaction of electrons when charged, forming the concept of electric current
- 4 state how an electromotive force may be produced by chemical, magnetic and thermal means
- 5 state the chemical, magnetic and thermal effects of an electric current
- 6 explain the properties and application of conductor materials used across the specialisms within the electrotechnical industry
- 7 explain the properties and application of insulator materials used across the specialisms within the electrotechnical industry
- 8 explain how current flow differs in series and parallel circuits
- 9 describe how voltmeters, ammeters are connected into circuits in order to quantify circuit voltages, current and resistance
- 10 describe the magnet fields and flux patterns set up by
  - a differing arrangements of permanent magnets
  - b current carrying conductors
  - c solenoids
- 11 describe the benefits of using an a.c. supply compared with a d.c. supply

- 12 describe the construction of basic transformers in terms of
  - a laminations
  - b primary and secondary windings
  - c enclosures, cooling
  - d SELV source
- 13 state the benefits gained by the use of transformers with the transmission and distribution of electrical energy (National Grid etc).
- 14 transpose and apply basic formulae to include base, derived units and related constants/factors
- 15 apply calculations involving force, mass, energy, power and efficiency
- 16 apply calculations related to 'Ohm's Law' & resistivity

## Outcome 3 Describe basic electrical circuitry and applications

### Practical Activities

The candidate will be able to

1. identify and select appropriate components to construct simple electrical circuits

### Underpinning Knowledge

The candidate will be able to:

1. state the component parts of an electrical circuit as
  - a source of supply a.c. or d.c.
  - b circuit conductor - cable
  - c circuit protection
  - d circuit control
  - e load
2. determine appropriate wiring systems, enclosures and equipment with reference to the
  - a use of single and three phase power systems
  - b installation of lighting circuits
  - c use of radial and ring circuits
3. state the component elements of electrical cables
  - a conductor
  - b insulation
  - c sheathing
  - d materials used for conductors
4. differentiate between the terms earthing and bonding and give examples of the usage of each
5. list possible exposed conductive parts and extraneous conductive parts of other metallic structures or services
6. state the purpose of earthing and the function of earth protection
7. list basic principles of shock protection, circuit overload and short-circuit protection.

## Outcome 4 Identify tools, plant, equipment and materials used for electrotechnical applications

### Practical Activities

The candidate will be able to

1. identify, select and use appropriate tools for basic applications
2. identify and fix appropriate components and fittings in electrotechnical systems

### Underpinning Knowledge

The candidate will be able to:

- 1 state the application and safe use of hand and power tools relative to their
  - a strength
  - b rigidity
  - c control of movement
  - d insulation properties
  - e hand tools – pliers, cutters, saws, strippers, screwdrivers, hammers, files, crimping tools, conduit benders, socket sets, spanners, soldering irons, solders and fluxes, riveting tools, measuring tools, levels, testing devices
  - f power tools - drills, saws, grinders,
- 2 state that electrically operated tools (110V a.c. or battery operated) undergo inspection checks prior to and after use
- 3 state the inherent risks of electric shock when using extension leads and electrical tools/equipment
- 4 state the need or safe handling and storage of tools, equipment and electrically operated tools
- 5 identify basic types of electrotechnical systems and features
  - a power sources
  - b wiring/cable systems
  - c controls
  - d electrical components
  - e supports/fixings
- 6 identify fitting/fixing activities
  - a isolation procedures
  - b check specifications
  - c determine appropriate fixing/fitting methods
- 7 identify and deal appropriately with potential hazards
  - a working at heights
  - b lifting and handling
- 8 identify good housekeeping
  - a leave the work area clear and tidy
  - b note environment conditions
  - c label and record finished work

# Unit 3 – 203 Application of Health and Safety and Electrical Principles

## Rationale

The aim of this core unit is to develop the candidates' ability to apply safe working practices and electrical principles to the methods of work employed within the industry.

There are five learning outcomes to this unit. The candidate will be able to:

- 1 describe safe systems of working.
- 2 use technical information, specifications and data in relation to electro technical equipment and systems
- 3 describe the basic principle of operation of electrical machines and alternate current theory
- 4 describe the basic principles and operation of polyphase.
- 5 describe the basic principles of over-current & short-circuit rated protective devices and earth fault protection

## Connection with other awards

This core unit combines with units 1 and 2 and one of the occupational units (4-9) to form the Level 2 Certificate in electrotechnology

## Assessment

- 1 Practical Activities  
These will be assessed by a practical assignment set and marked by the centre to a template provided by City & Guilds.
- 2 Written Tests  
The underpinning knowledge requirements are listed for each outcome. These will be assessed by a multiple choice question paper produced in accordance with the test specification.

# Outcome 1 Describe safe systems of working

## Practical Activities

The candidate will be able to

1. compile a list of the competencies required to work safely and effectively.
2. identify safety equipment in the workplace/shop/site.
3. carry out safe working practices.
4. carry out safe isolation to current industrial standards.
5. check that warning notices and barriers are sited and installed correctly.
6. check that the workplace/site conditions remain safe for work to continue.
7. check that all working equipment is in safe working condition.
8. ensure that on completion of work, all tools, equipment and materials are removed, stored safely and securely.

## Underpinning Knowledge

The candidate will be able to:

- 1 state the health & safety risks, precautions and procedures associated with tasks in the workplace
  - a health and safety risks and causes of accidents
    - i human - carelessness, improper behaviour, lack of training supervision, fatigue, drug alcohol abuse.
    - ii environmental – unguarded or faulty machinery and tools, inadequate ventilation, untidy, dirty, badly lit workplaces.
  - b precautions
    - i risk assessment
    - ii positive personal attitudes
  - c procedures
    - i personal protection
    - ii safety from electricity
    - iii emergency procedures
- 2 list the five main stages of a risk assessment process as being:
  - a identify the hazards
  - b evaluate the risks
  - c record the findings
  - d prepare and implement an action plan
  - e periodically review findings
- 3 list the common categories of risk as
  - a falling and tripping
  - b manual handling
  - c use of equipment, machinery and tools
  - d storage of goods and materials
  - e fire
  - f electricity
  - g mechanical handling

- 4 list the common option for risk control as
  - a elimination
  - b substitution
  - c enclosure
  - d guarding
  - e safe system of work
  - f supervision, training and information
  - g personal protective equipment
  
- 5 state the necessity to develop positive personal attitudes to safety in order to adopt safe systems of working.
  - a the need to act and work responsibly and safely in order to protect themselves, other people and the environment
  - b the need to know the hazards that can occur, the protection available and the means of preventing accidents
  
- 6 list safety procedures to prevent injury or accident
  - a personal protection
    - i personal protection, eye, face protectors, protective clothing,
    - ii safety guards, screens
  - b safety from electricity
    - i checking and inspection of cables, leads and plugs, earthing of portable equipment, reduced voltage equipment
    - ii action to take in the event of electric shock, isolation, removal, treatment
  - c emergency procedures
    - i fire drills, location of extinguishers, types of extinguishers
    - ii evacuation procedures, escape routes, assembly points
  
- 7 state methods of formalized, controlled methods of establishing safe access and exit from site to include site visitors' records, diaries
  
- 8 establish that access equipment is in safe working order and suitable for a specific task
  - a the safe angle for erecting ladders
  - b methods of securing ladders
  - c safety requirements when working with tower scaffolds
  - d the need for guard rails and toe boards on scaffolding
  - e select appropriate access equipment such as ladders, trestles, scaffolding, platforms and give examples of their correct use/limitations
  
- 9 state the need to secure tools and equipment in order to both avoid losses and maintain insurance cover.
  
- 10 identify emergency switches, isolators, alarms and emergency equipment in the workplace and describe methods of verifying and securing (locking off) isolation.
  
- 11 state the need to ensure that on completion of work, the workplace/site is cleaned tidied and left in a safe condition
  
- 12 state the rules for manual handling and lifting with reference to
  - a body position
  - b balance
  - c carrying
  - d safety of others
  
- 13 state correct procedures for
  - a removing unused and waste materials and equipment
  - b disposing of waste materials

## Outcome 2 Use technical information, specifications and data in relation to electrotechnical equipment and systems

### Practical Activities

The candidate will be able to:

- 1 use drawings, diagrams in conjunction with a related specification.
- 2 demonstrate the ability to distribute technical information by the use of:
  - a A written report
  - b BS, BSEN symbols on a suitable drawing or diagram
  - c E-mail
  - d Facsimile (fax) machine
- 3 identify the need to check that the recipient of the technical information can understand such information.

### Underpinning Knowledge

The candidate will be able to

- 1 describe the types of technical information as
  - a equipment and system specifications
  - b manufacturers' data
  - c working drawings
  - d reports and schedules
  - e user instructions
  - f job sheets/time sheets
- 2 interpret drawings, diagrams in order to produce, locate, or install electrical/electronic systems, equipment, machines or cabling
- 3 describe how dimensions, measurements may be transferred from a scaled drawing or diagram to a workplace or site
- 4 prepare materials lists and requisites from working drawings and specifications
- 5 state how to take in situ measurements
- 6 state the relevant people normally involved in the use of technical information
  - a operative
  - b supervisor
  - c contractor
  - d site agent/manager
  - e customer/client
- 7 describe the recording methods for the receipt and checking of materials, appliances, tools and equipment
- 8 describe the need to present the right image to recipients of the technical information by
  - a appearance
  - b manner/attitude
  - c confidence
  - d knowledge
- 9 state conventional and electronics methods of distributing technical information.
- 10 state the importance of ensuring that the recipient can understand the information distributed

## Outcome 3 Describe the basic principle of operation of electrical machines and alternate current theory

### Practical Activities

The candidate will be able to

1. undertake measurements within a.c. circuits

### Underpinning Knowledge

The candidate will be able to:

- 1 state the basic principle of operation of
  - a a.c. motors
  - b relays
  - c d.c. machines
  - d fluorescent luminaire
- 2 state with the operating principles of basic transformers in terms of:
  - a change in flux linkage
  - b concept of self and mutual inductance
  - c turns ratio
  - d step up and step down configurations
  - e potential and current transformers
  - f isolating transformer
- 3 recognise the effects of resistance, inductance, capacitance, reactance and impedance in a.c. circuits
- 4 define the term power factor
- 5 measure the power factor for an a.c. circuit in terms of kW, kVA and kVA<sub>r</sub>.
- 6 state why power factor correction is required and how this may be achieved.

## Outcome 4 Describe the basic principles and operation of polyphase systems

### **Practical Activities**

The candidate will be able to

1. undertake measurements in three phase circuits

### **Underpinning Knowledge**

The candidate will be able to:

- 1 describe the production/operation, transmission and distribution of energy by a polyphase system.
- 2 differentiate between voltages and currents in balanced star and delta connected three phase supplies
- 3 state the reason for balancing single phase loads across a three phase supply

## Outcome 5 Describe the basic principles of over-current and short-circuit rated protective devices and earth fault protection

### Practical Activities

The candidate will be able to

1. use appropriate regulations, requirements and other published data in order to establish the rated short-circuit capacities of protective devices (fuses & circuit breakers)

### Underpinning Knowledge

The candidate will be able to

- 1 state the need for protective devices
- 2 state that the selection of a protective device appropriate to the associated circuit or equipment depends upon
  - a prospective fault current
  - b circuit load characteristics
  - c cable current carrying capacity
  - d disconnection time limitation
- 3 list the exposed and extraneous conductive parts within a building that would form a circuit to the mass of earth or the main earthing terminal under a fault condition
- 4 list the essential requirements for a device fitted into a circuit or item of equipment to protect against over current
  - a operates automatically
  - b has a current rating related to the circuit design current
  - c has an operating current such that the disconnection time is within the design parameters
  - d has adequate breaking capacity
  - e is suitably located and identified
- 5 state the action of a fuse under fault conditions
- 6 state the need for correct 'discrimination' of devices when a number of devices are fitted between the supply and the load
- 7 state the causes of current flowing to earth in an installation, system or item of equipment
- 8 state the need to maintain a low impedance path to ensure that over current and earth fault protective devices will operate with design parameters
- 9 state the path taken by earth fault current from within the installation, back to the supply transformer and back to the fault position
- 10 state the need for supplementary protection against electric shock by the use of a RCD or RBO

# Unit 4 - 205 Installation (Buildings and structures)

## Rationale

This unit is an optional unit; it is concerned with the underlying principles related to electrical installation. It will include the understanding and use of statutory and non-statutory legislation, use of drawings and specifications the installation types, cabling and equipment which is used

There are four outcomes to this unit: The candidate will be able to

- 1 identify the relevant statutory regulations, Codes of Practice and Memoranda relevant to specific classes of electrical installation
- 2 identify the purpose and application of specifications, drawings, instructions and other data within an electrical installation
- 3 identify the different types of electrical installations and systems
- 4 describe methods of undertaking electrical installations, systems and components

## Connection with other awards

This occupational unit combines with the core units to form the Level 2 Certificate in Electrotechnical Technology

## Assessment

- 1 **Practical Activities**  
These will be assessed by a practical assignment set and marked by the centre to a template provided by City & Guilds
- 2 **Written Tests**  
The underpinning knowledge requirements are listed for each outcome. These will be assessed by a multiple choice question paper produced in accordance with the test specification.

# Outcome 1 Identify the Statutory Regulations, Codes of Practice and Memoranda relevant to specific classes of electrical installation

## Practical Activities

The candidate will be able to

- 1 follow agreed safe working practices in order to avoid creating a dangerous situation for self or others.
- 2 identify appropriate parts of the Electricity at Work Regulations, BS 7671, the IEE On-Site Guide relevant to electrical installations, Codes of Practice relevant to specific classes/types of systems, installations and equipment, and Health and Safety Executive 'Electricity at Work' booklet

## Underpinning Knowledge

The candidate will be able to:

- 1 state that the Electricity at Work Regulations concerns all aspects of electrical systems, equipment and installations that is to be or has been energised and that the EaW Regulations are statutory and therefore legally binding
  - a. explain that the EaW Regulations set standards which will reduce the risk of electric shock, burns, fire or explosion due to the use of electrical systems or equipment.
  - b. locate specific parts within the EaW Regulations that relate work based tasks in the installation within buildings and structures
  - c. state that contravention of the EaW Regulations may lead to litigation
- 2
  - a state how site based responsibility may make a person a designated 'Duty Holder' with some duties carrying responsibilities that may be categorised as being:-
    - i absolute
    - ii reasonably practical
  - b state the definition of systems
- 3 state how specific sections/topics within *BS7671* impact upon electrical installations within buildings and structures
  - a selection and erection of equipment
  - b isolation and switching
  - c inspection and testing
  - d protection against fire
  - e protection against electric shock
  - f protection against overcurrent
  - g special locations
- 4 state how data from the following may be used to support electrical installations
  - a BS 7671
  - b IEE Guidance Notes
  - c IEE On Site Guide
- 5 state current wiring regulatory requirements may impact upon the electrical installation process on-site.
- 6 state the need for statutory regulation of given hazardous installations
  - a potentially explosive atmospheres
  - b storage and delivery of petroleum
- 7 outline the requirements of Codes of Practice relevant to specific systems

- a earthing
- b lightning protection

8 state the purpose/function of a device or item of equipment identified by a BS or BSEN number within BS 7671

## Outcome 2 Identify the purpose and application of specifications, drawings, instructions and other data involved with electrical installations

### Practical activities

The candidate will be able to

- 1 identify sources of technical information
- 2 interpret charts, circuit drawings, wiring diagrams and schematic diagrams to facilitate installation processes

### Underpinning knowledge

The candidate will be able to

- 1 state the types of reference data and documentation as
  - a drawings, diagrams (circuit and wiring)
  - b specifications
  - c data charts
  - d manufacturers' manuals
- 2 state that technical information may be communicated by using
  - a technical drawings
  - b memorandum
  - c operations sheets
  - d data sheets
  - e exploded views
  - f electronic data, VDUs
- 3 state the purpose of drawings and specifications in order to determine
  - a the function and purpose of the installation
  - b materials, components and equipment required
- 4 interpret drawings and reference specifications in order to establish the type and location of an electrical installation and its associated components
- 5 state general information provided by drawings as
  - a scale
  - b parts by use of symbols
  - c routes/positions
- 6 state the function of the following in respect of an installation
  - a day work sheets
  - b job sheets
  - c time sheets
  - d delivery records
  - e reports

## Outcome 3 Identify the different types of electrical installations and systems

### Practical Activities

The candidate will be able to

1. identify different types of installation, electrical systems and components

### Underpinning Knowledge

The candidate will be able to

- 1 state types of electrical installation, components and related functions
  - a Lighting - providing functional levels of illumination in buildings and structures
  - b Heating - providing space and water heating and heating or commercial and industrial applications
  - c Power - providing circuits to drive electrical equipment, systems and components
  - d Environmental control – providing circuits and components to control heat/air
  - e Emergency management systems – providing circuits to support lighting/power in the event of a failure in the primary system
  - f Security and alarm systems – providing access/intruder controls and fire alarms
  - g Closed Circuit TV, communication and data transmission systems – providing specialised cabling for communication systems
- 2 state wiring systems and wiring enclosures
  - a Single and multicore thermoplastic (PVC) and thermosetting insulated cables (non-armoured)
  - b Single and multi core thermoplastic (PVC) and thermosetting insulated cables that have steel wire or non-magnetic armour
  - c Mineral insulated cable either with or without a PVC extruded sheath
  - d Steel conduit
  - e PVC conduit
  - f Metallic cable trunking
  - g PVC cable trunking
  - h Cable tray
  - i Ladder Racking
  - j Cable basket
  - k Armoured/braided control cables
  - l Data cables
  - m Optical fibre cable
- 3 state factors determining the choice of wiring systems, wiring enclosures and electrical equipment including
  - a ambient temperature
  - b effect of moisture on insulation
  - c corrosive substances
  - d UV rays
  - e damage by animals
  - f mechanical stress and vibration damage
  - g aesthetic considerations

- 4 state the factors affecting selection of conductor size such as
  - a design current
  - b control of voltage drop
  - c regulations concerning thermal constraints and shock protection.
  
- 5 carry out calculations to determine
  - a circuit current
  - b voltage drop
  - c protective device
  
- 6 state the application and limitations of specialised types of cables.
  - a *M.I., FP200* and proprietary cable such as '*Firetuf*' for fire alarm installations.
  - b cable types used in copper cabled communication networks.
  - c fibre optic cables.
  
- 7 describe the function, operation and wiring of components for electrical systems
  - a lighting
    - i switches
    - ii lamps
    - iii terminals and connections
  - b power and heating
    - i ring and radial circuits and sockets
    - ii cooking and water heating circuits
    - iii motors
    - iv industrial installations
    - iii controls – thermostats, timers, meters, switch gear
  - c alarm and emergency systems
    - i relays
    - ii detectors
    - iii controls
    - iv maintained and non maintained systems
  - d data/communication systems
    - i cables and components
  
- 8 state the special arrangements that need to be considered for
  - a bathrooms
  - b external installations
  - c flammable/explosive situations
  - d temporary and construction site installations
  - e agricultural and horticultural installations
  
- 9 state system earthing arrangements to include
  - a TN-S
  - b TN-C-S
  - c TN-C
  - d TT
  
- 10 state the arrangements for electrical systems with relevance to
  - a isolation and switching,
  - b overcurrent protection
  - c earth fault protection.

## Outcome 4 Describe methods of undertaking installations of systems and components

### Practical Activities

The candidate will be able to

1. identify working conditions at the installation site
2. recognise hazards and undertake safety procedures
3. install systems and components
4. inspect and test an installation

### Underpinning Knowledge

The candidate will be able to

- 1 state means of assessing and stating precautions necessary before commencing installation activities
  - a identify possible sources of hazards
  - b prepare work area, access equipment
  - c identify PPE required
- 2 state the procedures for ensuring any live equipment, cables or circuits may be safely and securely isolated and 'locked off'
- 3 state the need to liaise with other contractors in order to maintain a safe working environment
- 4 state the use of a work plan to
  - a identify task
  - b develop specifications, drawings
  - c check materials, tools and equipment
- 5 state the purpose and use of equipment for measuring and marking out
  - a rules, tapes
  - b gauges
  - c levels, plumbs
  - d squares
  - e scribes
- 6 state methods for measuring, marking out and fixing installation equipment
- 7 state the factors affecting the use of trunking, traywork and conduit in installations
  - a fittings, joints and terminations
  - b bends and elbow
  - c thermal movement
  - d protection of cables
  - e size and accommodation of cables
  - f fire barriers
- 8 state devices for fixing enclosures and equipment to surfaces
  - a woodscrews
  - b spring toggles
  - c girder clips
  - d crampets
  - e masonry bolts

- 9 identify suitable support and installation methods with regard to
  - a application
  - b load-bearing capacity
  - c fabric of structure
  - d environmental conditions
  - e aesthetic considerations
- 10 describe the support of cables in vertical or horizontal runs by means of clips, or saddles at intervals determined by size and by recommendations for spacing given within BS: 7671
- 11 state the use of tools and equipment for fixing and installing
  - a cable cutters, wire strippers, knives, saws, drills
  - b files, reamers, spanners, wrenches
  - c bending and forming machines
  - d adhesives
- 12 describe the safe use and storage of tools and equipment
  - a inspect tools before and after use
  - b use of low voltage for power tools
- 13 state suitable methods of restoring building fabric on completion of installation
- 14 state procedures for the correct disposal of waste materials
- 15 state requirements for successful installation as
  - a secure fixing of systems and components
  - b electrical continuity and maintenance of system integrity
  - c avoidance of damage to components and system
- 16 state the requirements for electrical installation testing
  - a inspection
  - b continuity of protective conductors
  - c ring final circuit
  - d polarity
  - e ensure correct operation of circuits